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ABSTRACT

This guide emphasizes the areas of elementary level mathematics, architecture, and visual arts and gives secondary emphasis to language arts/English and creative writing. The major goals are to develop an understanding of how the arts can enhance mathematical concepts, to describe mathematical qualities through the application of the arts, and to develop a sensitivity to the everyday uses of artistic forms in converting mathematical concepts into aesthetically pleasing concrete forms. The lesson plans contained in this document are grouped into the areas of: (1) "Measurement, Form, Shape, Building Models"; (2) "Math in Art and Poetry"; (3) "Computation"; (4) "Patterns and Shapes"; (5) "Descriptive Data"; and (6) "Graphing." Each lesson plan includes objectives, materials used, learning activities, and questions to ask in advance. One table summarizes the material in the eight guides. (DC)

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Resource Guide 8

CREATIVE MATH ACTIVITIES

Ronald T.Lee
SERIES EDITOR

This resource guide was originally developed through the arts in education program of the Plainedge Public Schools, Bethpage, New York.

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1989

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This project was made possible by the cooperative support of the New York State Council on the Arts, the New York Foundation for the Arts, and the New York State Education Department. The Inter-Agency Steering Committee for Arts in Education consisted of Julianna Sciolla (New York State Council on the Arts); Theodore Berger (New York Foundation for the Arts); Robert Reals (New York State Education Department – Bureau of Arts, Music and Humanities); and Robert Sullivan (State Education Department – Office of Cultural Education). The continued assistance and cooperation of Mr. Reals is noted, as is the unfailing interest and support of Charles J. Trupia (Director, Division of General Education, State Education Department). Laurie Rowe, Office of Federal Demonstration Programs, was a consistent supporter of the Arts in Education Network.

PREFACE

In 1980 eight school districts in New York State received ESEA Title IV-C funds to design, develop, and implement arts in education programs:

Community School District 3, New York City
Community School District 6, New York City
Homer Central Schools, Homer
Middle Country Central School District, Centereach
New Rochelle City Schools, New Rochelle
Plainedge Union Free Schools, Bethpage
Syracuse City Schools, Syracuse
White Plains City Schools, White Plains

The teachers and project staff members from these districts have written, tried, and evaluated an impressively large number of lesson and unit plans, and resource and curriculum guides. The ideas, methods, and resources contained in these materials are valuable not only to the teachers using them but also to classroom and arts teachers in other districts interested in implementing arts in education programs.

This series of resource guides has been designed by Ronald Lee, series editor, from the materials developed through efforts of these eight districts. For this purpose collaborative money was provided through the New York Foundation for the Arts by the New York State Council on the Arts and the New York State Education Department. The series consists of eight guides:

Resource Guide One
THE IDEABOOK
New Rochelle City Schools
Six essays written by teachers

Resource Guide Two
THE WRITE WAY ON
Syracuse City Schools
Strategy plans and ideas for creative writing

Resource Guide Three
INTEGRATING SOCIAL STUDIES AND FOLK MUSIC
Middle Country Central School District, expanded and rewritten by Cindy L. Daly
Instructional units and resources on social studies and folk music

Resource Guide Four
COMMUNICATION THROUGH THE ARTS
Syracuse City Schools
Learning activities for verbal and non-verbal communication

Resource Guide Five
ALTERNATE LEARNING EXPERIENCES FOR CREATIVE EXPRESSION
Homer Central Schools
Prototypes for encouraging creative expression

Resource Guide Six
EARTH, AIR, FIRE, AND WATER
Community School District 3, New York City
Activities and resources, suggestions for networking

Resource Guide Seven
ARTS IN THE EDUCATION OF CHILDREN WITH SPECIAL NEEDS
Community School District 6, New York City
Activities for bilingual, gifted, and special education students

Resource Guide Eight
CREATIVE MATH ACTIVITIES
Plainedge Union Free Schools
Lesson plans for creative thinking in mathematics

Most of the guides also include appendices containing a variety of sample forms, ideas, and other materials used successfully in the eight programs. The following table shows the grade level(s) for which each guide was written, and the non-arts and arts areas covered. Main emphasis is indicated by an X, secondary emphasis by an (X).

Resource Guide	GRADE LEVEL			NON-ARTS AREAS								ARTS AREAS							
	Elementary	Junior High	Senior High	Foreign Culture/ Language	Geography	Language Arts/ English	Mathematics	Science Technology	Social Studies/ History	Community Resources	Resource Center/ Library	Architecture	Creative Writing	Dance/Movement	Folk Art/Crafts	Media Arts	Music	Theatre Arts	Visual Arts
1. The Ideabook	X	X		(X)	(X)	X	X	X	X	(X)	X	(X)	X	X	(X)	X	X	X	X
2. The Write Way On	X					X	(X)	(X)	(X)	X			X				(X)		(X)
3. Integrating Social Studies and Folk Music	X	X	(X)		(X)	(X)			X	(X)	(X)				X		X	(X)	(X)
4. Communication Through the Arts	X	(X)				X			X	(X)				X	(X)	X	X	X	X
5. Alternate Learning Experiences for Creative Expression	X	X	X	(X)	(X)	X	(X)	X	X	X	(X)	(X)	X	X	X	X	X	X	X
6. Earth, Air, Fire and Water	X	(X)		(X)	(X)	(X)		X	(X)	X	(X)	(X)	X	X	X		X	X	X
7. Arts in the Education of Children With Special Needs	X			X	X	X		(X)	(X)	X			X	X	(X)		(X)	X	X
8. Creative Learning Experiences in Math	X					(X)	X					X	(X)						X

TABLE 1

Two other publications coming from the efforts of teachers in the eight districts are THE NETWORK NOTEBOOK: A CASEBOOK FOR ARTS IN EDUCATION written by Carol Fineberg, and MARA — MATHEMATICS/ARCHITECTURE RELATED ACTIVITIES, a publication drawn from the Architects-in-the-Schools projects, primarily in the White Plains City Schools. These publications are available from the Bureau of Arts, Music and Humanities Education, Division of General Education, The New York State Education Department, Albany, New York 12234.

INTRODUCTORY INFORMATION

1

INTRODUCTION

Over the past several years, the Plainedge Public School District has made a concentrated effort to systematically infuse each of the basic subject areas with the arts. To that end, teachers have produced Arts Infused Curriculum Packets with suggested classroom activities in the areas of social studies, language arts and mathematics.

Every effort is made to bring to the students and community an increased awareness of the arts as universal expressions of all that humans feel, see, touch, taste, smell and imagine.

The major goals of Creative Learning Experiences in Math are to have the students:

1. Develop an understanding of how the Arts can enhance, clarify and depict mathematical concepts and abstractions.
2. Learn to describe, interpret, analyze and judge mathematical qualities through the application of the arts.
3. Develop a sensitivity to the everyday uses of artistic forms in converting mathematical concepts into aesthetically pleasing concrete forms (i.e., advertising, packaging fashion design, architecture including homes, malls, shops, schools, parks, airports, skyscrapers).

ORGANIZATION OF THE GUIDE

This guide is designed to be a source of ideas for classroom and arts teachers. It contains new and creative methods to make the arts "come alive" within mathematics.

The lesson or unit plans are divided into six areas:

- Measurement, Form, Shape, Building Models
- Math in Art and Poetry
- Computation
- Patterns and Shapes
- Descriptive Data
- Graphing

Each lesson plan consists of four sections: the objective(s), materials used, learning activities, and questions to ask in the evaluation process.

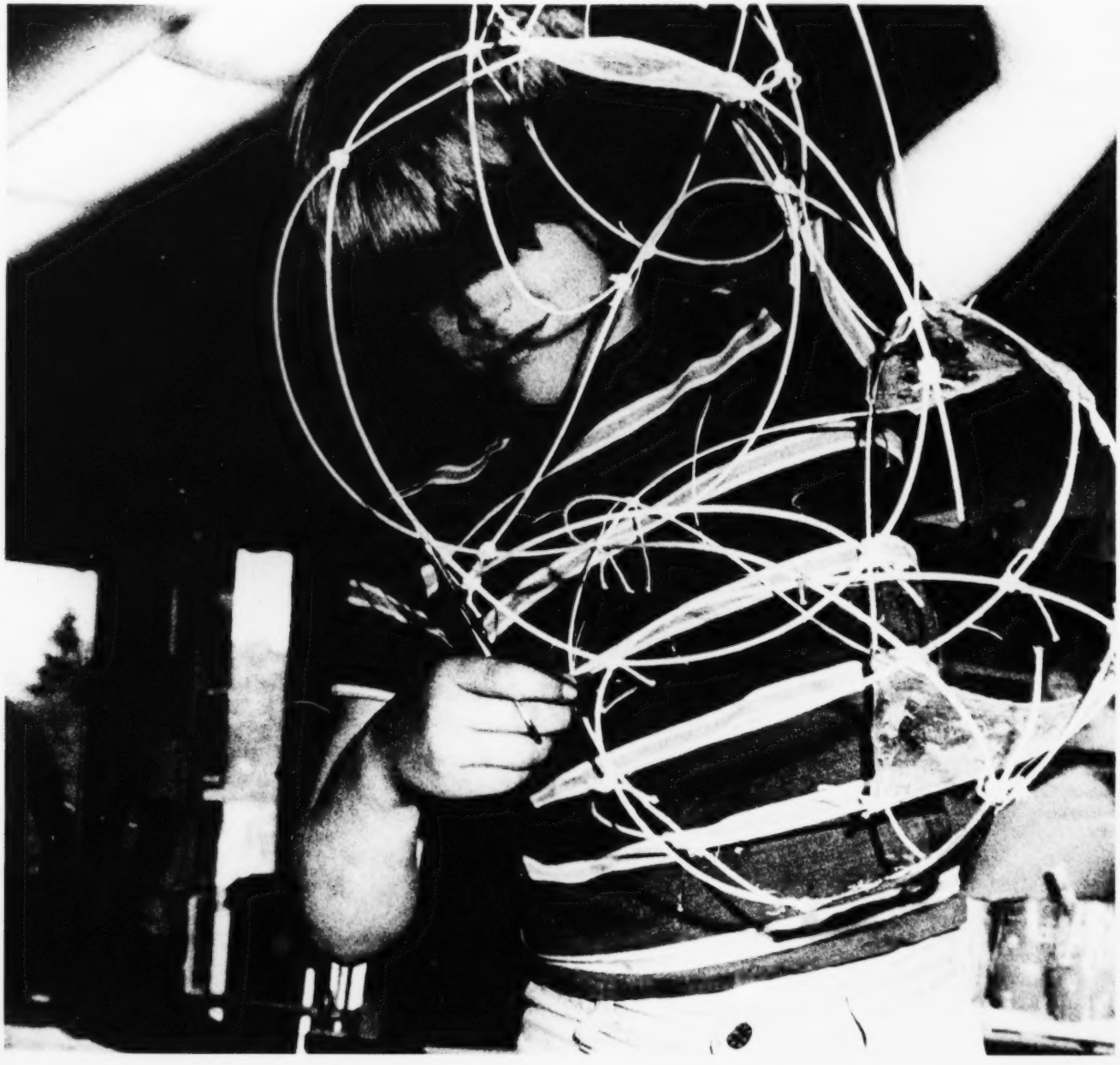
As you use the ideas in the lesson plans, you should consider three important questions:

- How can these ideas be used successfully in *my* situation?
- In what manner will incorporating these ideas make *my teaching more effective*?
- How do these ideas *fit into the educational goals* I have set for my students?

Once these questions have been answered, you can design and develop your lesson plans or units. The next step is to try them and then evaluate their effectiveness.

In addition to the resources suggested in this guide, you should consult with the arts specialists in your school district. Incorporating instruction by music and art teachers will enrich the learning activities in your lesson plan or unit. And, do not forget the numerous cultural opportunities available in your city and surrounding region. Community artists, museums, and performing arts groups are often very interested in assisting you and your school in identifying ways to integrate the arts into the mathematics education of your students.

EXPERIENCES AND RESOURCES



5

Measurement, Form, Shape, Building Models

Model Houses, Villages, Towns

OBJECTIVE

To apply arithmetic and measurement skills in an architectural project

MATERIALS

Balsa wood, cardboard, knives, hammers, saws, markers, glue, social studies and history books

ACTIVITIES

1. Have students read about settings in a particular period of America's past. Using balsa wood, cardboard, knives, hammers, etc., depending upon how complex the project will be, students draw to scale designs of what they will accomplish, and from the plans, they construct their projects. Use measures extensively; scale must be understood and applied.
2. Have students estimate costs for an architectural or interior design.
   a. Design a structure to scale. The design could be for a classroom, bedroom, cafeteria, playground, or a structure for a favorite pet.
   b. Consider the purpose of the structure: what is to be done in the structure, what materials are to be used, and how aspects such as light, ventilation, entrances and exits are to be handled.
   c. Investigate the cost of different materials and how quantities of materials are sold.
   d. Calculate how much of each material is needed and the cost.
   e. Make a final presentation including drawings to scale (i.e., floor plan, elevation of each wall, individual plans for special objects such as benches, beds, desks, etc.).

EVALUATION

Did each student design and execute a project, using math concepts? Was the project done to scale and artistically pleasing? Were all calculations correct?

SAMPLE CHART LISTING

Location	Material to be Used	Quantity	How Much Needed	Overall Cost

Measurement

OBJECTIVES

- To measure using a ruler
- To draw straight, parallel lines using a ruler
- To develop fine motor manipulative skills
- To develop a sense of organization and design

MATERIALS

Rulers, magazines, scissors, markers, pencils, construction paper

ACTIVITIES

1. Have each student cut a picture out of a magazine. Depending on the age of the student and complexity desired, select the unit of measure. Divide the picture into *equal units* of the *same shape* (squares, rectangles, triangles).
2. Have the student create interesting distortions by:
   a. Shifting shapes so they do not line up correctly.
   b. Eliminating some shapes.
   c. Expanding the picture by leaving space in between.
   d. Contracting the picture by slightly overlapping shapes to make the picture smaller.

EVALUATION

- Did the students demonstrate how parts of a picture fit together?
- Were the students able to use a ruler successfully, not only for measurement but also for insuring the consistency of size and for creating parallel lines?

Proportion-Graph Designs

OBJECTIVE

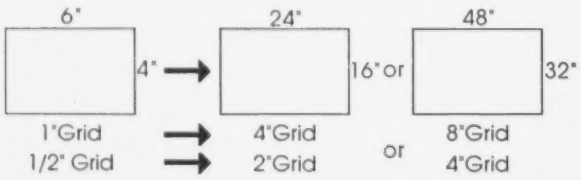
To enlarge proportionately using graph coordinates

MATERIALS

Graph paper, rulers, pencils

ACTIVITIES

1. Have the student create a picture or design relating to personal experiences or interpreting historic or literary events.
2. Have the student place a graph (preferably 1/2" to 1" grid) over the picture and mark the coordinates.
3. Decide how much larger the finished works should be and increase the graph accordingly.



4. Whenever a line from the drawing bisects a line of the grid, make a mark. Repeat the pattern to each box as it appears on the original drawing.

EVALUATION

Did the student successfully enlarge the drawing by plotting and interpreting graph coordinates?

Enlarging or Reducing Patterns

OBJECTIVE

To enlarge or reduce a pattern

MATERIALS

Picture, diagram or pattern to be enlarged or reduced, pencils, rulers, construction paper, graph paper

ACTIVITIES

1. Show the students how to enlarge or reduce a pattern, so that they can use it for mapwork, an illustration, etc. First, draw vertical and horizontal lines over the top of the pattern. Use a ruler, and space the lines about 1/2" apart. To enlarge the pattern, draw the same number of horizontal and vertical lines on another sheet of paper, but space these lines 1" apart. On this paper, in each square, draw exactly what is in the corresponding square of the pattern. The picture or map will be exactly twice a big as the original.
2. To reduce a pattern, draw a grid with vertical and horizonal lines spaced 1/4" apart. On this paper, in each square, draw exactly what is the corresponding square of the pattern. The new picture will be exactly one-half the size of the original pattern.

EVALUATION

Did the students enlarge or reduce patterns and shapes accurately?

Measuring to Scale in Primary Grades

OBJECTIVES

- To "pace out" a measurement
- To create a scale drawing by using a non-standard, personal scale

MATERIALS

1/4" or 1/2" grid paper, room of the student's choice

ACTIVITIES

1. Have the students "pace out" the measurements of the room of their choice. Count the number of paces in length and width, and record these numbers.
2. Transfer the number of paces taken in each case to grid paper. Let one box correspond to one pace. In this manner, each student creates a scale drawing of the room.
3. Discuss the following questions:
   a. Is the ceiling measurement the same as the floor?
   b. What kind of shape is your room?
   c. How many corners does your room have?
   d. Why do different children find different amounts of paces for the dimensions of the room?

EVALUATION

- Did the students pace out a room and numerically describe the room dimensions?
- Were the students able to translate the data gathered and transfer these numbers to grid paper?

Forms and Shapes

OBJECTIVES

- To identify shapes and forms
- To translate line to geometric shapes to solid (three- dimensional) shapes
- To compute perimeter, area, volume

MATERIALS

Cardboard, clay, construction materials, rulers, markers

ACTIVITIES

1. Have the students draw geometric shapes, and transform these shapes into solid forms of the same size.
2. Have the student select or create a product to be packaged. What form and size does the package have to take in order to hold the product?

EVALUATION

- Did the students construct the solid forms accurately?
- Was the student able to compute perimeter, area and volume?

Proportion Ratio

OBJECTIVES

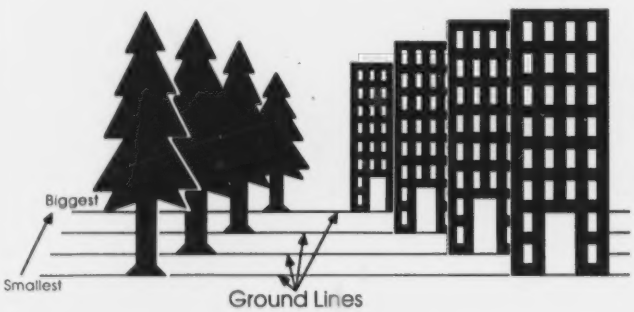
- To translate "greater than," "less than," "bigger than," "smaller than," visually and numerically.
- To calculate sizes in proportion
- To understand the theory of perspective

MATERIALS

Construction paper, markers

ACTIVITIES

1. Create a model for a stage design from a story or a play. Discuss the sizes and proportions of the background forest trees or buildings.
2. Divide the class into four or five groups, each group having a progressively smaller piece of paper. Each group designs a tree or a building the size of its paper. Trees or buildings are then arranged on ground lines indicating foreground (biggest), midground (big), and background (smallest) of varying distances.



3. Once the basics are in place, have the students figure the size of other objects within the same ground line and add them accordingly.

EVALUATION

- Did the students demonstrate an understanding of ratios of one size to another, and relate them to the project?
- Did the students demonstrate an understanding of perspective?

Discovering the Environment

OBJECTIVE

To develop an awareness of both the natural and the built environment by increasing the ability to observe details, similarities, differences, and relationships.

MATERIALS

Paper, pencils

ACTIVITIES

1. Suggest the following activities to the students:
   a. Sit in your room and take a good look at it. Then make a drawing of everything that is in it.
   b. Draw a front elevation of your house or apartment building and point out the things that make it unique.
   c. Plot the fastest way home from school and make a map of it.
   d. List all the different kinds of buildings between your home and school. Note how many stories each has and what building materials were used.
   e. List all of the materials (e.g., wood, plaster, plastic) used in your classroom.
   f. Measure the classroom and make a scale plan of it. Then, using dotted lines, map the traffic patterns into, within, and out of the room. Jot down such observations as how the room is heated, cooled, ventilated, and lighted; and what furniture and equipment are located in the room. How might the room be changed?
   g. What would an ideal classroom look like? Make a plan, a drawing, a list of details, or a narrative description of it.

EVALUATION

Was the student able to observe similarities, differences, and relationships in the environment and apply mathematical concepts?

Creating Art Media from Raw Ingredients

OBJECTIVES

- To use measuring tools with liquid and dry materials
- To follow a recipe (formula)
- To create a three-dimensional form

MATERIALS

Cornstarch, salt, baking soda, water, wax paper, cloth, plastic bags, flour, alum, paint, food coloring, markers

ACTIVITIES

1. Have the students follow recipes to create a substitute material for clay:

   FLOUR CLAY

   Mix { 1 cup flour; 1 cup salt; 1 rounded teaspoon alum }

   Add water slowly and knead until clay-like consistency is reached.

   CORNSTARCH CLAY

   Mix { 1/2 cup cornstarch; 1 cup salt; 1 cup boiling water }

   Boil to a soft-ball stage and knead on wax paper.

   or

   Mix { 1 cup cornstarch; 2 cups baking soda; 1 1/4 cups cold water }

   Blend thoroughly, cook over medium heat (4 minutes) until the mixture thickens to a moist mashed potato consistency. Cover with a damp cloth to cool. Knead.

   Store all mixtures in a plastic bag until they are used.

2. Have the students create imaginary creatures or objects related to classroom subject matter, using the clay. The objects may be painted when they are finished, or food coloring may be added to the different batches before the students create the objects.

3. Ask the students to describe the geometric properties of the sculptures (e.g., curves, angles, planes, symmetry, weight).

EVALUATION

- Did the students demonstrate the ability to measure ingredients?
- Did the students manipulate the "clay-like" material and create three-dimensional objects?

Math In Art And Poetry

Combining Math, Poetry and Art

OBJECTIVE

To design mathematical problems which are consistent with creative thinking

MATERIALS

Poems, paper, pencils

ACTIVITIES

1. Read the poem "Arithmetic" by Carl Sandburg and discuss it with the class.
2. Have each student select a stanza and write a series of math examples, or problems which illustrate the stanza.
3. Have each student design pictures, cartoons, and diagrams which express the poem and the math involved.
4. Read the poem "Henry the Accountant" and have students design math examples or problems which Henry might have had to solve.

EVALUATION

Did the students demonstrate creative thinking?

Geometry in Famous Art

OBJECTIVES

- To recognize geometric shapes used by artists in famous paintings
- To use geometric shapes in a painting or drawing

MATERIALS

Prints illustrating paintings composed of geometric shapes

ACTIVITIES

1. Show prints to the class and discuss the geometric shapes illustrated in each painting. The discussion can lead to further study by individual students.
2. Have the students design and paint pictures using geometric shapes.

EVALUATION

- Were the students able to see geometric shapes in works of art?
- Did the students use geometric shapes in their own art work?

Arithmetic

Arithmetic is where numbers fly like pigeons in and out of your head.

Arithmetic tells you how many you lose or win if you know how many you had before you lost or won.

Arithmetic is seven eleven all good children go to heaven—or five six bundle of sticks.

Arithmetic is numbers you squeeze from your head to your hand to your pencil to your paper till you get the answer.

Arithmetic is where the answer is right and everything is nice and you can look out of the window and see the blue sky—or the answer is wrong and you have to start all over and try again and see how it comes out this time.

If you take a number and double it and double it again and then double it a few more times, the number gets bigger and bigger and goes higher and higher and only arithmetic can tell you what the number is when you decide to quit doubling.

Arithmetic is where you have to multiply—and you carry the multiplication table in your head and hope you won't lose it.

If you have two animal crackers, one good and one bad, and you eat one and a striped zebra with streaks all over him eats the other, how many animal crackers will you have if somebody offers you five six seven and you say No no no and you say Nay nay nay and you say Nix nix nix?

If you ask your mother for one fried egg for breakfast and she gives you two fried eggs and you eat both of them, who is better in arithmetic, you or your mother?

Carl Sandburg

Henry the Accountant

(to the tune of John Henry)

Henry was an accountant
He worked with a pencil in his hand
If you had something you needed figured out
Then Henry the accountant was your man Lord, Lord
Henry the accountant was your man
I said Henry the accountant was your man Lord, Lord
Henry the accountant was your man

When Henry was a little baby
Sittin' on his daddy's knee
He picked up a crayon and a little piece of paper
He said "Two plus one equal three"

Now the man who bought the first calculator
He thought he was mighty fine
He walked up to Henry with a sneer on his lip
He said, "Your job is gonna be mine"

So Henry stood up and drew his weapon
He said, "A man isn't anything but a man
We'll have ourselves a race and I'll put you in your place
Or I'll die with my pencil in my hand"

So each man grabbed a fifty pound ledger
And Henry went to work with all his might
Though his hand was getting cramped and his shirt was getting damp
Still he swore that he would not give up the fight

After three long hours in battle
The man with the machine moved out ahead
He had Henry beat till on the final sheet
Suddenly his batteries went dead

So Henry beat that calculator
Now his power could never be denied
But the terrible strain had been too much for his brain
So he laid down his glasses and he died

So they buried Henry in the graveyard
With his trusty pencil and his pad
And when their checks don't clear they always shed a tear
For the last human being who could add

Spending Money

OBJECTIVE

To create story problems involving money and present solutions in creative ways

MATERIALS

Food advertisements from newspapers, magazines, coupons, construction paper, markers, rulers, nutritional guides

ACTIVITIES

1. Have the students plan a menu of three meals and snacks for a family of four for a day or more. They are to work within an assigned budget. For realistic prices, they should use food advertisements from newspapers, magazines, and flyers. The planned meals should reflect good nutritional balance (vitamins, minerals, calories, proteins, carbohydrates, fats). They are to present their meal plan in the form of charts and diagrams designed in a creative manner.
2. Use the same format as above, except for a different purpose, such as purchasing clothing. Students must show math examples, and present their spending decisions in a creative way.

EVALUATION

Did the students present charts or diagrams which graphically represent solutions to relevant math problems?

Combinations-Georgio's Pizza, Plain or Fancy

OBJECTIVE

To strengthen computational and problem-solving skills

MATERIALS

Drawing paper, crayons, scissors

ACTIVITIES

1. Have the students draw and paint pictures of a pizza. Also, have them draw and paint mushrooms, anchovies, salami, pepperoni, and meatballs. Cut out the pizzas and additional ingredients.
2. Ask the students to "order" any of the extra toppings for Georgio's Plain Pizza. The pizza costs $\$_____$.

Toppings and Prices

A. Mushrooms—75¢	**E. Peppers—45¢**
B. Anchovies—60¢	**F. Meatballs—$1.25**
C. Salami—65¢	**G. Extra Cheese—95¢**
D. Pepperoni—80¢	

How many different combinations of pizza can one make by using none, any, or all of the extras? What is the total cost for each combination? *Remember:* A combination of mushrooms and anchovies is not different from a combination of anchovies and mushrooms. If three friends were sharing the costs, how much would each person pay for each combination?

TABLE OF COMBINATIONS FOR EXTRA TOPPINGS

None	One	Two	Three	Four	Five	Six	All

EVALUATION

- Did the students develop a procedure to ensure the listing of all possible combinations?
- Did the students solve computational problems with at least 85% accuracy?

Money Notation

OBJECTIVES

- To itemize verbally and numerically
- To compute money transactions
- To communicate personal wishes or ideas into visual objects

MATERIALS

Cardboard, construction paper, list of foods found on a menu, art supplies, examples of menus

ACTIVITIES

1. Ask the students to address and solve the following situation:

   You are opening a new restaurant in town. Your funds are limited; as a result, you can sell only fifteen different items. Create a menu for your new restaurant. Remember, you need a name for the cover of the menu and names for fifteen items, plus their descriptions and prices. Out of the items, some should be:

   Entrees
   Side Orders
   Desserts
   Beverages

   Your menu should be attractive, well organized, and easy to read.

2. Have the students take orders from other students, using their menu, and calculate the bills.

EVALUATION

- Did each student interpret the value of food items into numerical symbols and then calculate the sum?
- Did each student create an attractive menu?
- Did each student compute money transactions accurately?

Number Symbols

OBJECTIVES

– To identify number symbols and words

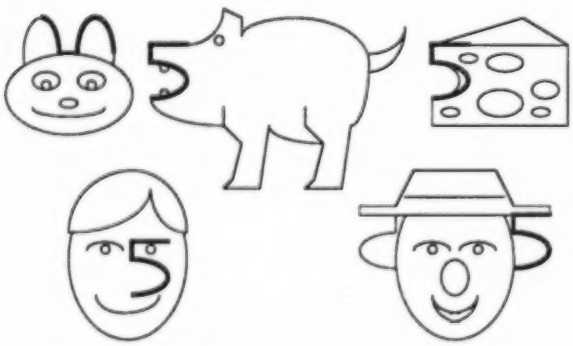
– To analyze numbers in terms of shape and line

MATERIALS

Numbers, art supplies, cartoons from newspapers

ACTIVITIES

1. Have each child pick a number (i.e., "five") out of a basket.
2. Have each student use the number symbol to create pictures representing the amount.



3. Have the children write creative stories and poems, using the numbers selected.

EVALUATION

Did the students creatively transform number symbols into pictorial representations?

Problem Solving

OBJECTIVE

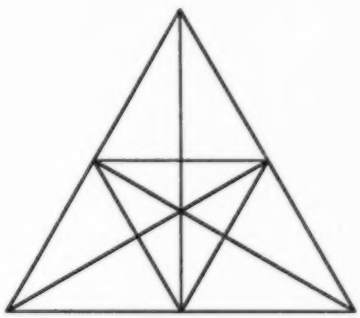
To apply logical thinking and recognize patterns while solving problems

MATERIALS

Construction paper, rulers, markers, fabric, "odds and ends"

ACTIVITIES

1. How many different triangles are there? Have the students color designs or draw new patterns.
2. Have the students make up story problems of their own and design creative solutions.



How many different ways can a boy combine one of each of the following: three pairs of shoes, five shirts, four pairs of trousers, two sweaters, six pairs of socks?

3. Have the students demonstrate their answers by drawing, painting, or pasting used fabric to "dress" the boy.

EVALUATION

Did the students demonstrate creative ways to solve story problems?

Shadows Measure Height

OBJECTIVES

- To learn how geometry is used to measure tall heights
- To measure tall objects

MATERIALS

Sticks, rulers, construction paper, markers

ACTIVITIES

1. Take a stick, place it upright in the ground and wait until its shadow is the same length as the stick. At the same time the length of the shadow of a nearby flagpole would be the same as the length of the flagpole. If you did not want to wait until the precise time the stick's shadow was the same length of the stick, there is a way to proceed:
   a. Measure the length of the stick, the length of the stick's shadow, and the length of the flagpole's shadow.
   b. Multiply the length of the stick x the length of the flagpole's shadow. Divide the answer by the length of the stick's shadow. This gives the height of the flagpole. Since the angle of the sun is identical on both the stick and the flagpole, the triangles formed are of proportionate size. The size of one triangle is in direct ratio to the size of the other. The problem is one of ratio:

$$\frac{\text{Stick Shadow}}{\text{Stick Height}} : \frac{\text{Flagpole Shadow}}{\text{Flagpole Height}}$$

   All numbers are known except the flagpole height.

$$\frac{(\text{Length of stick} \times \text{length of flagpole shadow})}{\text{Length of stick shadow}} = \text{Height of pole}$$

   This method can be used to measure and identify the heights of trees, buildings, and other structures.
2. Have the students determine the height of trees, flagpoles, and other objects on the school grounds.

EVALUATION

Did the students apply the ratio formula for measuring heights of various structures?

Equality

OBJECTIVES

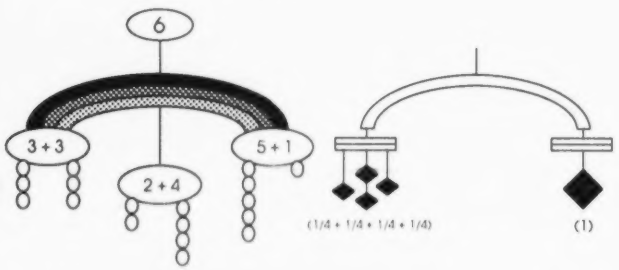
- To understand principles of equality
- To use an art form to illustrate computation, equality of equations, and fractions

MATERIALS

Construction paper, wire hangers, markers, fabrics, pipe cleaners, etc.

ACTIVITIES

1. Have students list the equations they wish to illustrate.
2. Assist the students in constructing mobiles to illustrate the equations.



EVALUATION

- Do students demonstrate the meaning of equality in their choice of equations?
- Do students use the "mobile" as an art form to correctly present an equation?

Patterns and Shapes

Identifying Geometric Shapes

OBJECTIVE

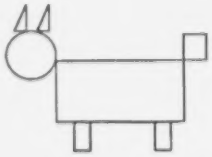
To learn to identify a circle, triangle, square, and rectangle

MATERIALS

Printed worksheets or cutouts of shapes, construction paper, markers, pencils

ACTIVITIES

1. Have the students trace shapes (in assorted sizes); then cut the shapes. Each student should cut at least four sizes of each shape.
2. Ask the students to count the number of sides in each shape.
3. Have the students color the shapes and arrange them into designs, either abstract or representational. Is there anything in the classroom that looks like these shapes?
4. Arrange the shapes in sequential patterns and challenge the children to continue creating patterns and shapes.



EVALUATION

- Can the students name each shape used in the design? Can they count how many of each shape they used in making designs?
- Can the students tell how many sides are in each geometric shape?
- Can the students describe the similarities and differences among the geometric shapes?

Symmetry

OBJECTIVES

- To observe examples of symmetry in the environment
- To use symmetry to arrange a repeated pattern

MATERIALS

Mirrors, paper, copies of letters of the alphabet, symmetrical objects, paint or ink

ACTIVITIES

1. Explain symmetry and show students objects which are symmetrical (e.g., starfish, wheels).
2. Make a blot design on a sheet of paper. Fold it exactly in half and show the symmetrical design.
3. Vertical symmetry
   a. Using mirrors, have the children view letters of the alphabet: A, H, M, O,T, V, W, X, Y. These letters can be divided in half lengthwise.
   b. Fold paper in half vertically and cut a shape from the folded paper. When you open the paper, each half has vertical symmetry. The perfect balance of the two shapes makes the designs artistically pleasing.
4. Horizontal symmetry
   a. Place a mirror along the horizontal center line of a design. If each horizontal half is an exact reflection of the other, the design has horizontal symmetry.
   b. Using mirrors, have the children view the letters of the alphabet: C, D, E, H, I, O, X. Each has horizontal symmetry.
   c. Use the folded paper technique, but this time, horizontally. Cut a shape from the

folded paper, and open the paper to find a design with horizontal symmetry.

5. Vertical and horizontal symmetry
   a. Have the students cut a design with both vertical and horizontal symmetry by folding the paper in half both vertically and horizontally. Cut through all four thicknesses to create the design, and open the folds to illustrate a perfectly symmetrical shape.
6. Assign visual arts projects to the students in which they draw or paint designs that are symmetrical (i.e., repeated patterns, reflections, equal rotations).

EVALUATION

- Did the students identify examples of symmetry in their environment?
- Did the students demonstrate the use of symmetry in their visual arts projects?

Geometry in Nature

OBJECTIVES

- To observe mathematical designs in nature
- To create original designs using geometric figures

MATERIALS

Seeds, stems, leaves, and variety of fruit, construction paper, markers, rulers, compass

ACTIVITIES

1. Have the students observe fruits, seeds, and leaves, and describe the points, lines, surfaces and spheres.
2. Have the students use geometric lines and shapes to design pictures of fruits, seed, and leaves, either making copies or designing creative representations.

EVALUATION

- Did the students observe geometric shapes in natural things?
- Were the students able to create designs of their own using geometric lines and shapes?

Parallel Lines

OBJECTIVES

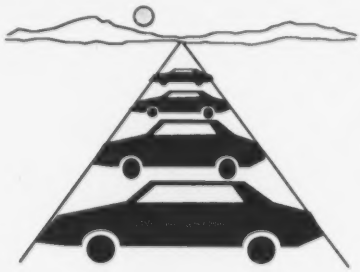
- To understand the mathematical term "parallel," and see and understand the use of parallels in the environment
- To use "vanishing point" in landscape drawings

MATERIALS

Drawing paper, pencils, markers

ACTIVITIES

1. Show large pictures of railroad tracks or highways. Railroad tracks are parallel, but when one looks down the tracks, it appears as if the two rails meet in the distance.
2. Have the students draw pictures to make objects grow smaller as they recede into the distance. First, draw the horizontal line – the line where the sky and earth meet. Make a dot anywhere on that line; the dot is the vanishing point. Draw in the objects at the bottom of the picture, and lines to connect both sides of each object to the vanishing point. Draw in the remainder of the picture fitting the size within the lines along to the vanishing point. The objects will recede as they go into the distance.



EVALUATION

- Did the students understand the mathematical concept of parallel?
- Were the students able to apply the idea of "vanishing points" in their drawings?

Descriptive Data

Pictographs

OBJECTIVE

To use statistics and express them in an artistic, graphic form

MATERIALS

Almanac, texts, encyclopedia, atlas, construction paper, graph paper, mural paper, markers, rulers

ACTIVITIES

1. Have the students use reference material to gather factual information about assigned situations.
2. Have them design a PICTOGRAPH to chart the data. For example:

= 10 children

EVALUATION

- Did the students present statistical information in an artistic, graphic way?
- Can they describe verbally what their graphs denote?

Statistics

OBJECTIVES

- To develop a method of gathering and organizing information
- To record data in graphic forms

MATERIALS

Paper, pencils, graph paper, construction paper, rulers

ACTIVITIES

PRIMARY GRADES

1. Ask the question: How do we come to school? Bus? Car? Walk? Collect similar information about favorite pets, birthdays, heights, and weights. Have the students record the information themselves using charts such as the following:

How do we come to school?						
BUS						
CAR						
WALK						

INTERMEDIATE GRADES

1. Take a survey about favorite music performers, favorite soft drinks, favorite fast-food restaurants, and other descriptive data. Have the children design bar graphs, circle graphs, pictographs, accurately recording the data.

EVALUATION

- Were the students able to discuss the importance and uses of descriptive statistics?
- Were the students able to represent gathered data in graphic form?
- Did the students demonstrate the ability to read graphs and to compare different data?
- Did the students compare the advantages and disadvantages of various forms of graphs?

Probability

OBJECTIVES

- To develop an understanding of probability experiments
- To refine their intuitive concepts of probability and their techniques for organizing data

MATERIALS

Deck of cards, crayons, paper, markers, pencils, red blocks, green blocks

ACTIVITIES

PRIMARY GRADES

1. From a box with red and green blocks, have each child pick a block without looking, while the teacher records the results for the class. Each child puts the block back into the box before the next child's turn. To record the results, color in boxes on a chart:

RED									
GREEN									

2. Ask the following questions:

   How many reds were picked?
   How many greens were picked?
   Could there ever be a tie in the number of reds and greens?
   How many red and green blocks are in the box?
   If we play again, what do you think can happen?
   If we change the number of blocks in the box, what do you think will happen?
   If we change the colors of the blocks, what do you think will happen?

INTERMEDIATE GRADES

1. Use a deck of cards, shuffle, and have each student pick a card. Record whether it is a diamond, heart, club, or spade. Return the card to the deck, and continue to shuffle, pick, and record for fifty turns. The data can be recorded on the following chart:

RECORD OF TRIAL PICKS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
DIAMOND																									
HEART																									
CLUB																									
SPADE																									

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
DIAMOND																									
HEART																									
CLUB																									
SPADE																									

2. For older children, use at least one hundred picks. What part of the total picks were diamonds? Hearts? Clubs? Spades? Add all the fractional parts.

EVALUATION

- Were the students able to predict outcomes of the experiments?
- Were the students able to compare the actual results of the experiments with expected results?
- Did the students undertake other experiments involving random selection, and make meaningful analyses of anticipated results?

Graphing

OBJECTIVES

- To apply rules concerning graphing
- To use fundamental operations in designing graphs
- To create original designs using principles of graphing

MATERIALS

Pencils, erasers, rulers, scrap paper, 1/4" and 1/2" graph paper

ACTIVITIES

The following are self-directed activities in graphing. They range in level of difficulty from simple to difficult. The basics of graphing should have been taught prior to directing students to these activities.

Note that some of the activities are for single quadrant solutions while others are four quadrant types. Single quadrant problems may be done on 1/2" graph paper; other sized graphs may be used to accommodate individual needs.

EVALUATION

- Did the students demonstrate an understanding of the principles of graphing?
- Did the students design graphs accurately?

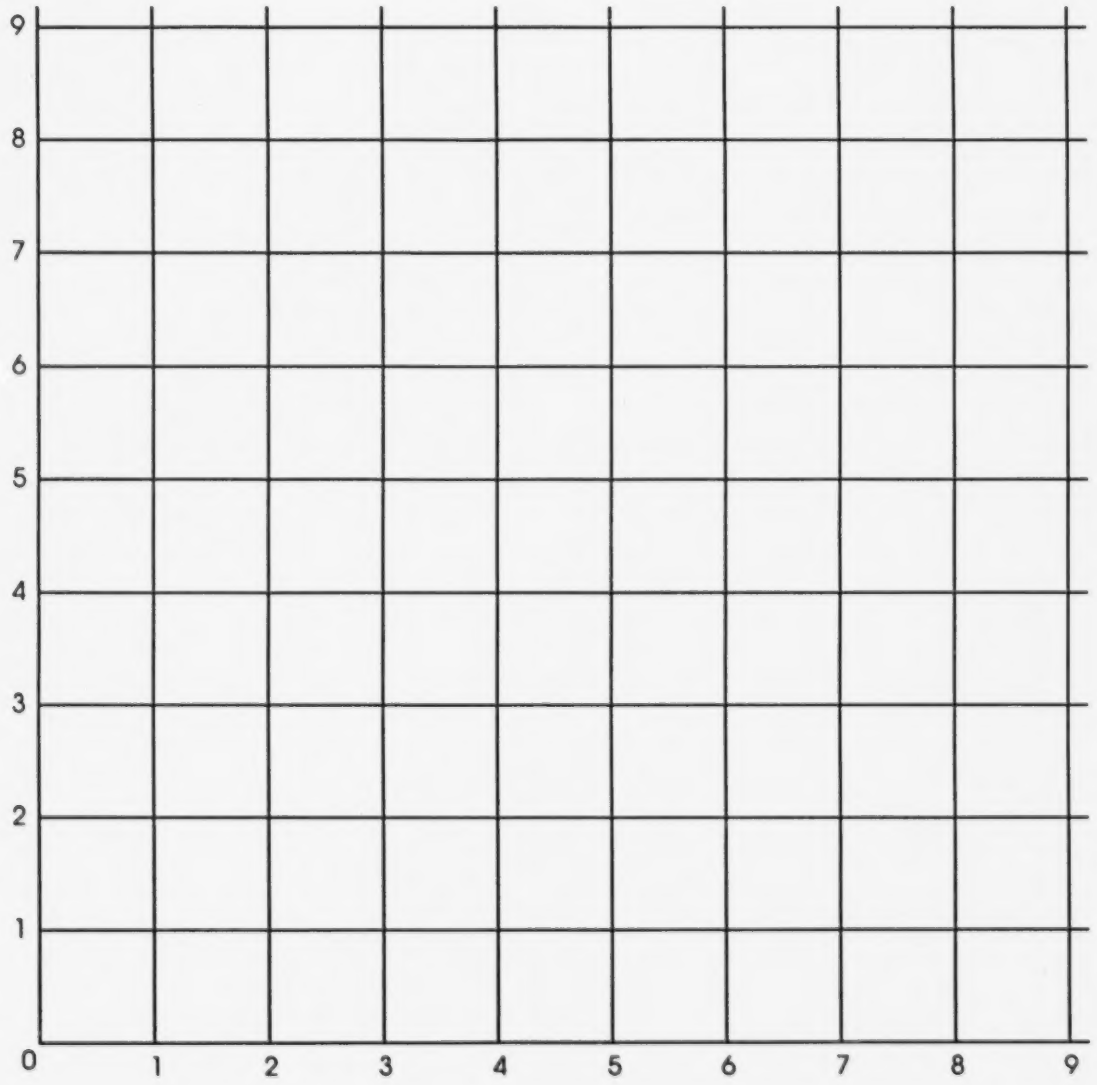
ACTIVITY ONE (EASY)

1. Using the following coordinates, plot this picture on Graph A.

(1) 2, 2	(3) 5, 1	(5) 4, 5	(7) 2,2	(9) 4,2
(2) 3,1	(4) 6,2	(6) 4,6	(8) 6,2	(10) 4,5

2. Be sure to connect all points in order.
3. Add a flag to the mast and plot its coordinates. List them.

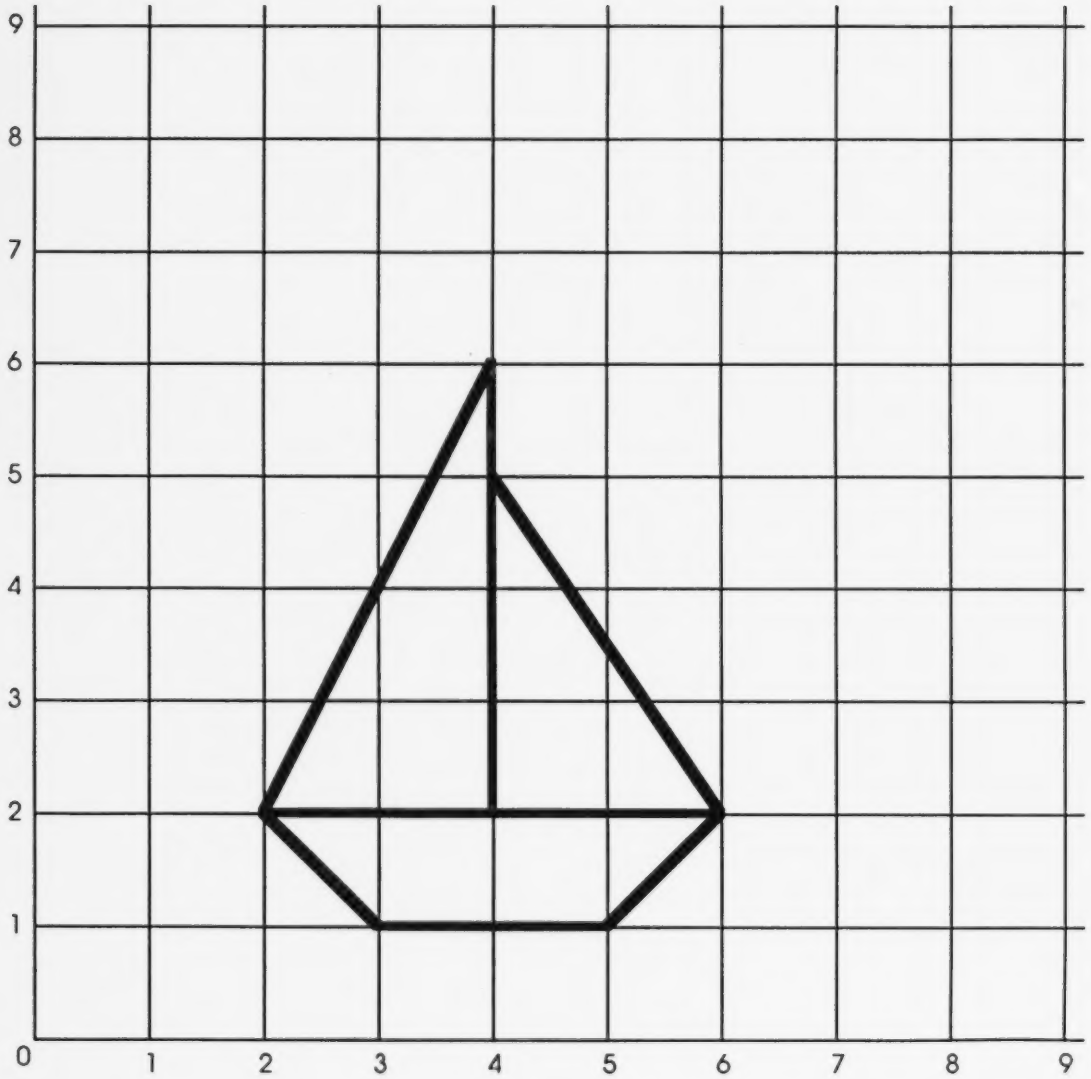
Graph A



Graph A

(Correct Solution)

(1) 2, 2	(3) 5, 1	(5) 4, 5	(7) 2,2	(9) 4,2
(2) 3,1	(4) 6,2	(6) 4,6	(8) 6,2	(10) 4,5



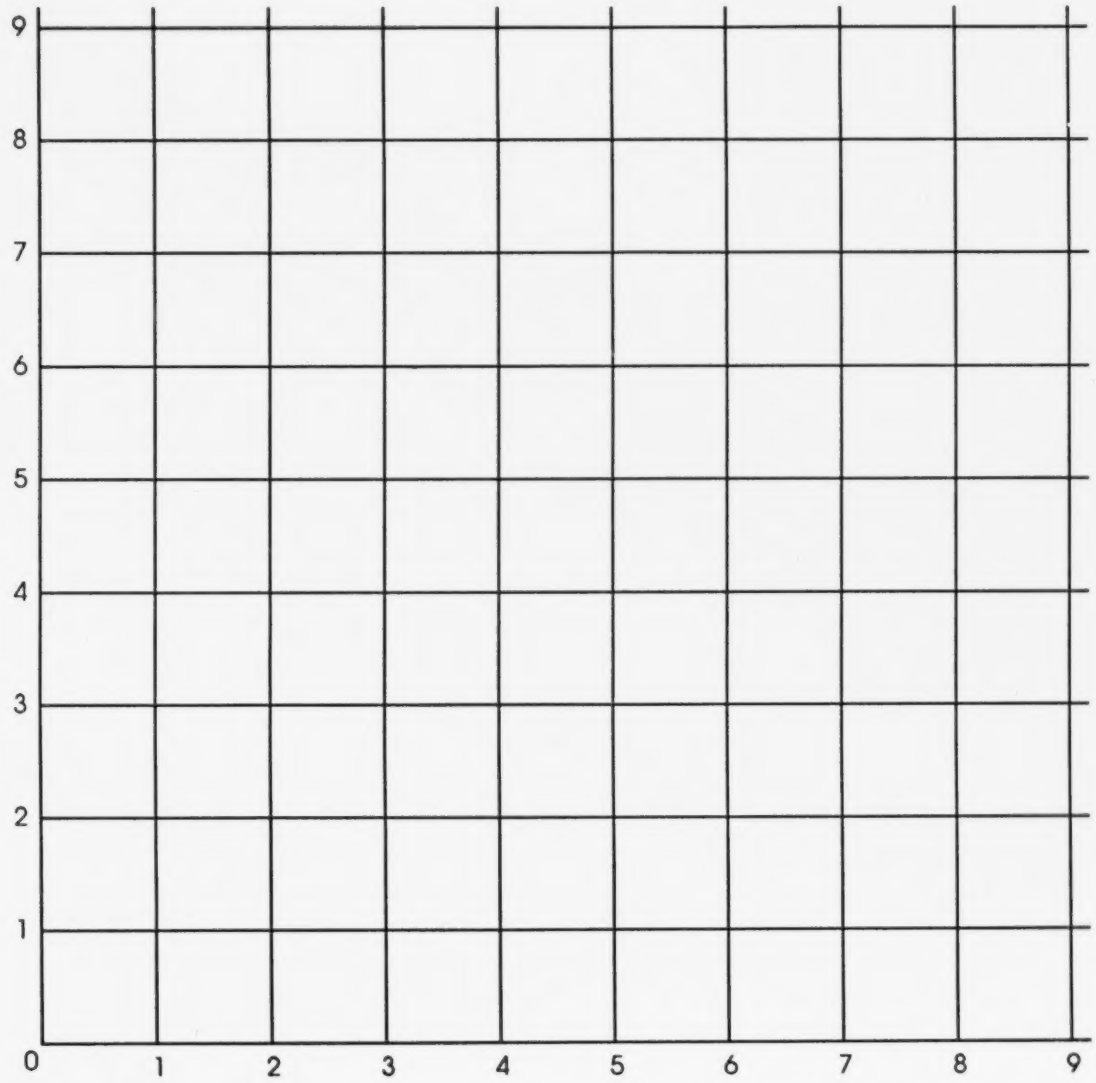
ACTIVITY TWO (EASY)

1. Using the following coordinates, plot this picture on Graph B.

(1) 0,1	(4) 2,1	(7) 4,1	(10) 6,2	(13) 8,3	(16) 4,5
(2) 1,2	(5) 3,2	(8) 6,1	(11) 6,4	(14) 7,3	(17) 1,5
(3) 1,1	(6) 4,2	(9) 5,2	(12) 8,4	(15) 6,2	(18) 0,1

2. Be sure to connect all points in order.
3. Can you add features to this picture and determine the coordinates? List them.

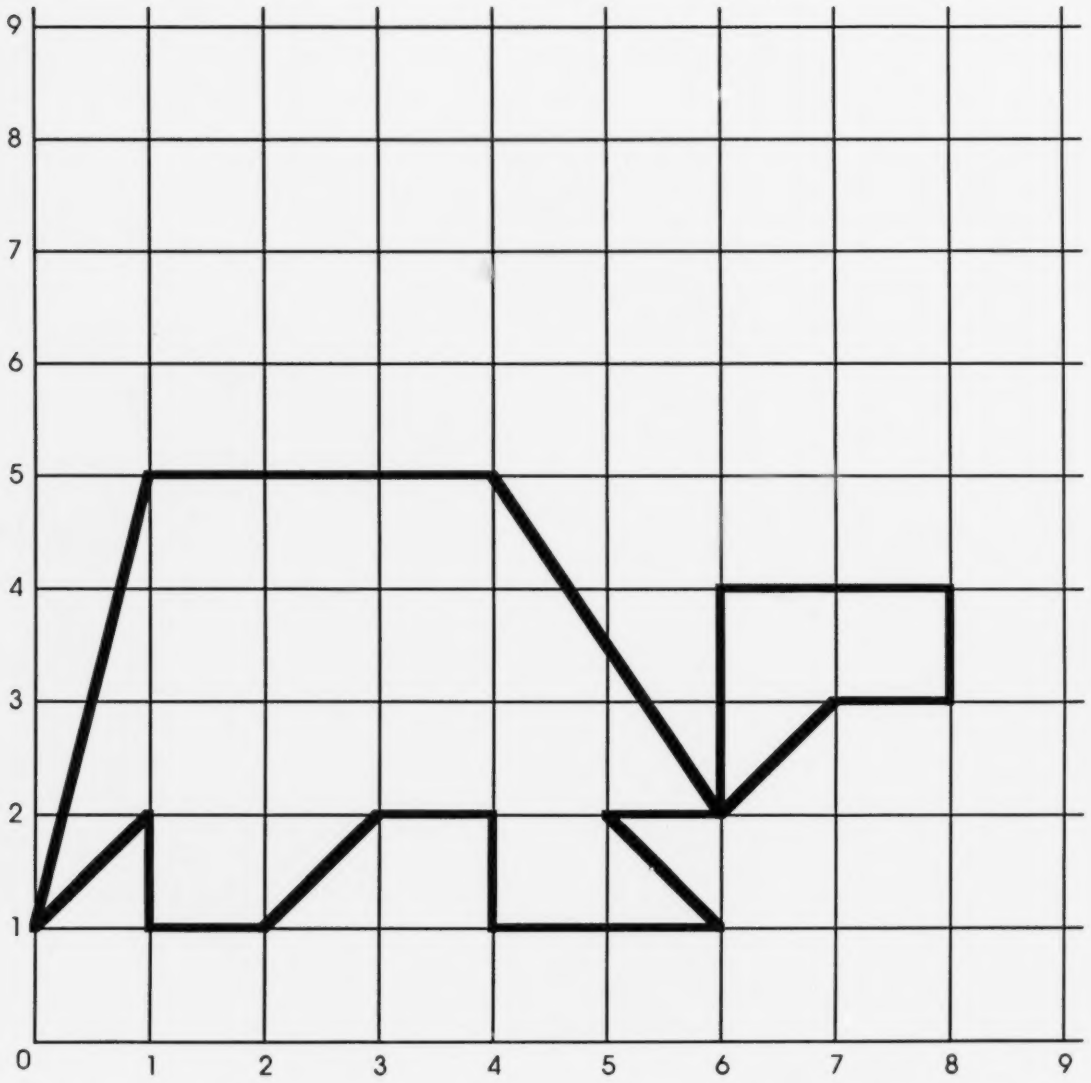
Graph B



Graph B

(Correct Solution)

(1) 0,1	(4) 2,1	(7) 4,1	(10) 6,2	(13) 8,3	(16) 4,5
(2) 1,2	(5) 3,2	(8) 6,1	(11) 6,4	(14) 7,3	(17) 1,5
(3) 1,1	(6) 4,2	(9) 5,2	(12) 8,4	(15) 6,2	(18) 0,1



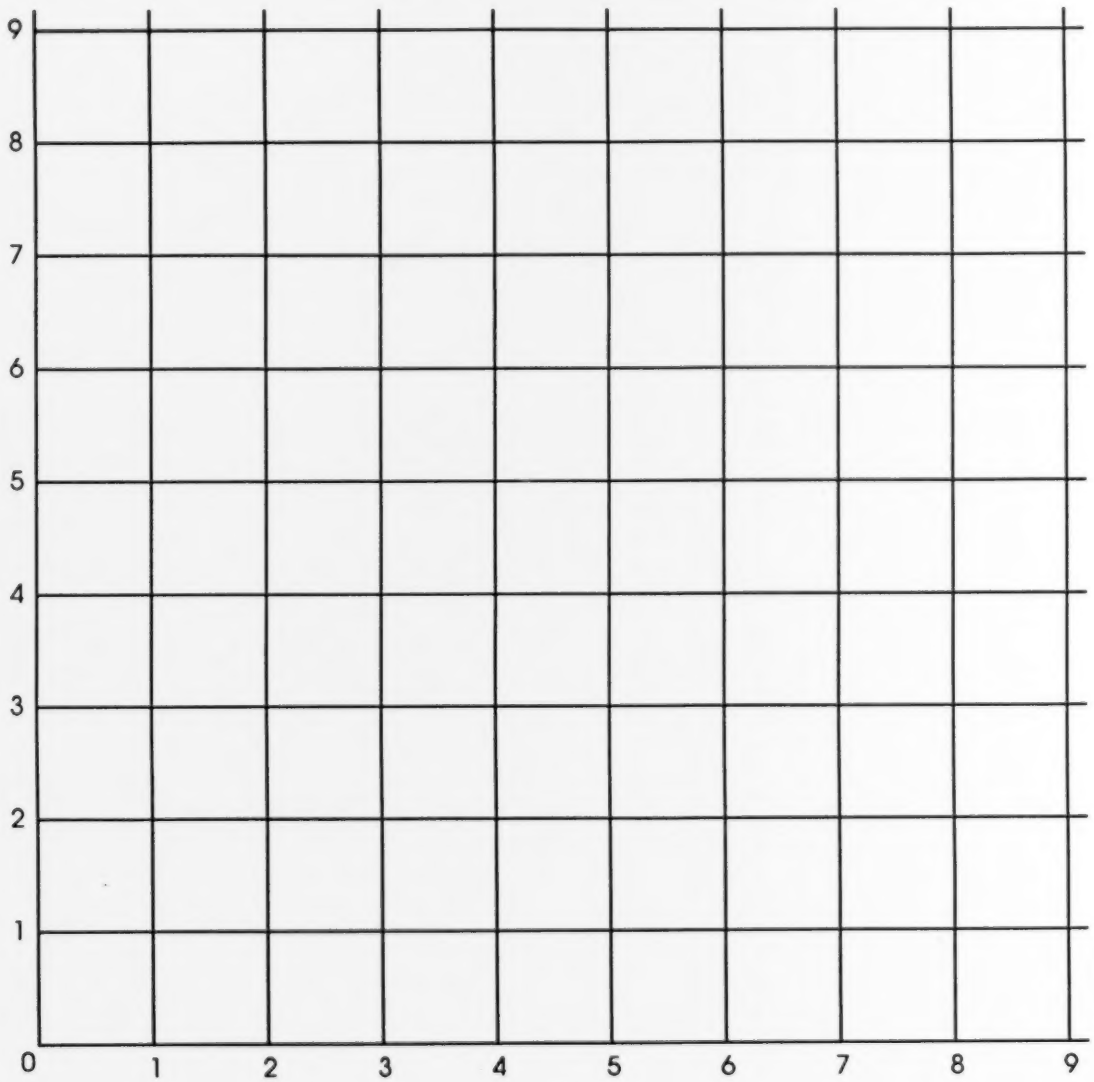
ACTIVITY THREE (EASY)

1. Using the following coordinates, plot this picture on Graph C.

(1) 4,0	(4) 4,9	(7) 5,5	(10) 6,4	(13) 5,2
(2) 2,2	(5) 4,7	(8) 6,4	(11) 6,3	(14) 4,2
(3) 2,7	(6) 5,7	(9) 9,4	(12) 5,3	(15) 4,0

2. Be sure to connect all points in order.
3. Can you draw a bigger ship and plot its coordinates? Try it.

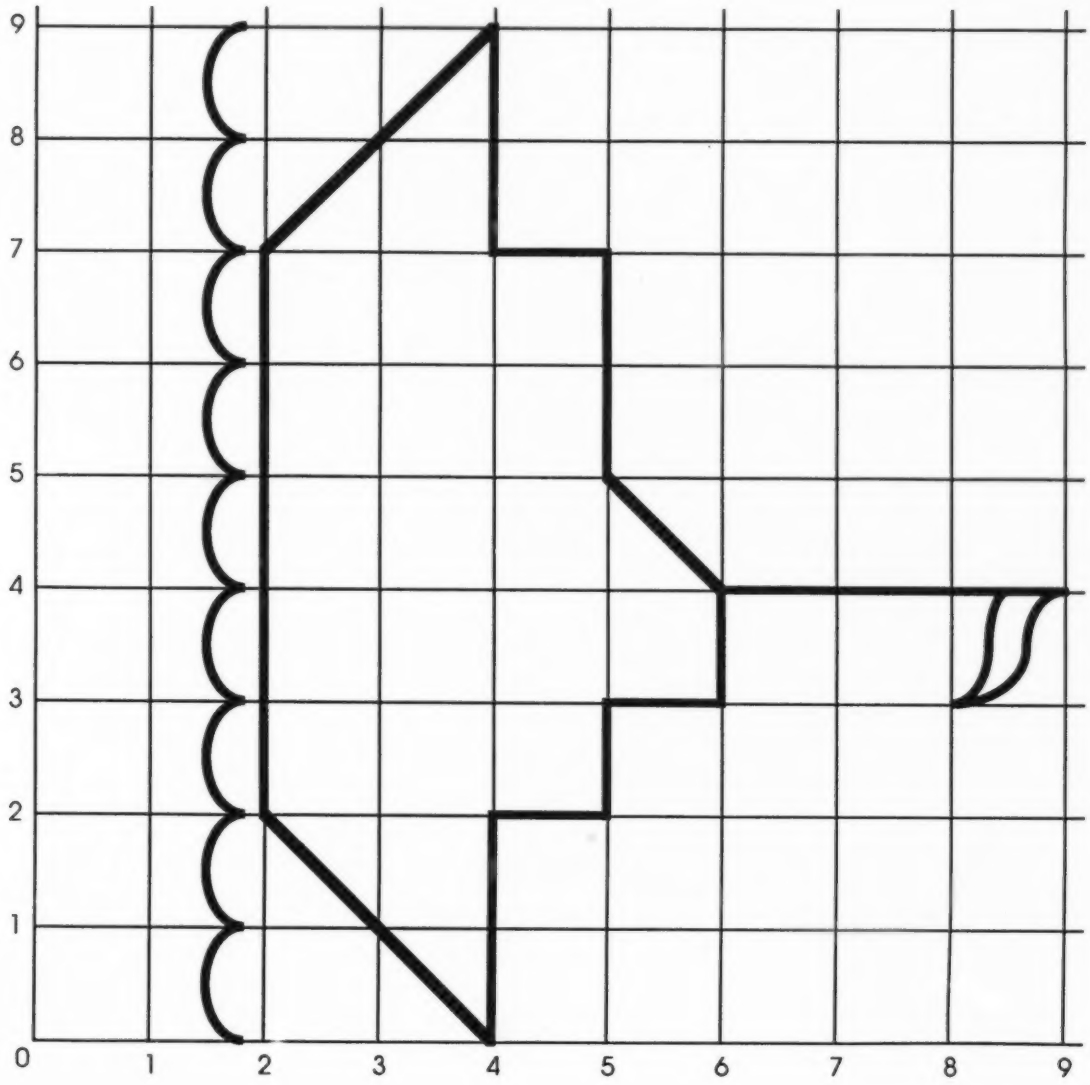
Graph C



Graph C

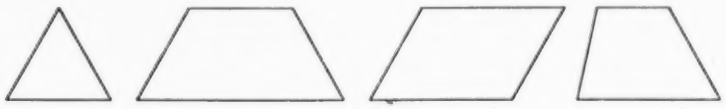
(Correct Solution)

(1) 4,0	(4) 4,9	(7) 5,5	(10) 6,4	(13) 5,2
(2) 2,2	(5) 4,7	(8) 6,4	(11) 6,3	(14) 4,2
(3) 2,7	(6) 5,7	(9) 9,4	(12) 5,3	(15) 4,0



ACTIVITY FOUR (MEDIUM DIFFICULTY)

1. Draw a simple figure such as a house on graph paper. Plot all the coordinates.
2. Double each coordinate. Draw your new figure using the doubled coordinates.
3. What was the area of your first figure? What was the area of your second figure? What happened to the size of the area when you doubled the coordinates?
4. Try the same thing with the following figures:



ACTIVITY FIVE (HARD)

1. Using one quadrant only, draw or copy a picture on graph paper. Set up your vertical and horizontal lines and number them.
2. Write all the coordinates for the picture.
3. Using another piece of graph paper, follow your coordinates. Do you get the same picture? If not, go back over your work and find your error.

Hint: Keep your picture very simple. Try this out by drawing a square or a rectangle. First, see if you can do it. If so, try something harder.

ACTIVITY SIX (VERY HARD)

1. Draw a picture, following the same procedures as on Activity Five, *BUT* this time, make your coordinates for a four quadrant graph.

Hint: Keep your picture very simple. Try this out by drawing a square or a rectangle. First, see if you can do it. Then, try something harder.

ACTIVITY SEVEN (VERY HARD)

1. Do this activity *only* if you think you can work carefully, patiently, and you really want to be challenged.
   a. Solve each of the forty-three pairs of equations on the Student Worksheet.
   b. Place each pair of answers in the corresponding "coordinates" column. When you have done this, you will have forty-three sets of coordinates.
   c. Prepare your graph so that you can fit all your coordinates in.
   d. Graph your picture.
2. Can you make a similar problem of your own?

ACTIVITY SEVEN
Student Worksheet

			Coordinates
(1)	$3 \times 1 =$ _____,	$0 \times 3 =$ _____	_____, _____
(2)	$6 - 3 =$ _____,	$8 - 6 =$ _____	_____, _____
(3)	$8 \div 4 =$ _____,	$3 + 2 =$ _____	_____, _____
(4)	$6 \div 6 =$ _____,	$14 \div 2 =$ _____	_____, _____
(5)	$16 \times 0 =$ _____,	$5 \times 2 =$ _____	_____, _____
(6)	$8 - 7 =$ _____,	$6 + 7 =$ _____	_____, _____
(7)	$10 - 8 =$ _____,	$7 \times 2 =$ _____	_____, _____
(8)	$1 + 1 =$ _____,	$9 + 4 =$ _____	_____, _____
(9)	$7 \div 7 =$ _____,	$10 \times 1 =$ _____	_____, _____
(10)	$16 \div 8 =$ _____,	$9 - 1 =$ _____	_____, _____
(11)	$10 \div 5 =$ _____,	$6 + 4 =$ _____	_____, _____
(12)	$10 - 7 =$ _____,	$8 + 6 =$ _____	_____, _____
(13)	$13 - 9 =$ _____,	$9 + 6 =$ _____	_____, _____
(14)	$10 \div 2 =$ _____,	$11 + 4 =$ _____	_____, _____
(15)	$2 \times 2 =$ _____,	$8 + 5 =$ _____	_____, _____
(16)	$7 - 3 =$ _____,	$2 + 9 =$ _____	_____, _____
(17)	$9 - 5 =$ _____,	$10 - 2 =$ _____	_____, _____
(18)	$11 - 6 =$ _____,	$15 - 2 =$ _____	_____, _____

ACTIVITY SEVEN

Student Worksheet (cont'd)

			Coordinates
(19)	8 − 1 = _____,	14 + 1 = _____	_____, _____
(20)	16 − 8 = _____,	17 − 2 = _____	_____, _____
(21)	9 + 0 = _____,	19 − 4 = _____	_____, _____
(22)	12 − 3 = _____,	16 − 2 = _____	_____, _____
(23)	15 − 8 = _____,	17 − 4 = _____	_____, _____
(24)	3 × 2 = _____,	20 − 10 = _____	_____, _____
(25)	10 − 4 = _____,	11 − 3 = _____	_____, _____
(26)	4 + 3 = _____,	11 − 1 = _____	_____, _____
(27)	4 + 6 = _____,	7 + 4 = _____	_____, _____
(28)	24 ÷ 2 = _____,	1 × 10 = _____	_____, _____
(29)	18 − 5 = _____,	13 − 5 = _____	_____, _____
(30)	9 + 3 = _____,	12 ÷ 2 = _____	_____, _____
(31)	17 − 6 = _____,	11 − 4 = _____	_____, _____
(32)	4 × 3 = _____,	6 + 2 = _____	_____, _____
(33)	20 ÷ 2 = _____,	18 − 9 = _____	_____, _____
(34)	12 − 4 = _____,	5 + 3 = _____	_____, _____
(35)	19 − 10 = _____,	15 − 10 = _____	_____, _____
(36)	6 + 5 = _____,	36 ÷ 9 = _____	_____, _____
(37)	22 − 11 = _____,	18 ÷ 3 = _____	_____, _____
(38)	14 − 2 = _____,	36 − 6 = _____	_____, _____
(39)	16 − 3 = _____,	32 ÷ 8 = _____	_____, _____
(40)	24 ÷ 2 = _____,	10 ÷ 10 = _____	_____, _____
(41)	30 ÷ 3 = _____,	2 − 1 = _____	_____, _____
(42)	16 ÷ 2 = _____,	8 ÷ 4 = _____	_____, _____
(43)	21 ÷ 3 = _____,	4 × 0 = _____	_____, _____

ACTIVITY SEVEN

(Correct Solution)

(1) 3, 0	(9) 1,10	(17) 4, 8	(25) 6, 8	(33) 10, 9	(41) 10, 1
(2) 3, 2	(10) 2, 8	(18) 5,13	(26) 7,10	(34) 8, 8	(42) 8, 2
(3) 2, 5	(11) 2,10	(19) 7,15	(27) 10,11	(35) 9, 5	(43) 7, 0
(4) 1, 7	(12) 3,14	(20) 8,15	(28) 12,10	(36) 11, 4	
(5) 0,10	(13) 4,15	(21) 9,15	(29) 13, 8	(37) 11, 6	
(6) 1,13	(14) 5,15	(22) 9,14	(30) 12, 6	(38) 12, 6	
(7) 2,14	(15) 4,13	(23) 7,13	(31) 11, 7	(39) 13, 4	
(8) 2,13	(16) 4,11	(24) 6,10	(32) 12, 8	(40) 12, 1	

ACTIVITY SEVEN

(Correct Solution)